

NEW FOSSIL CHITONS FROM THE MIOCENE AND PLIOCENE OF VICTORIA

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Plates xix-xxi.

At the request of Dr. Sule, of Prague, Czechoslovakia, Edwin Ashby made arrangements with Walter Greed, of Hamilton, Victoria, to collect fossiliferous earth from three exposures in Victoria.

By a special process, and by using millimetre and half-millimetre sieves, Dr. Sule washed out from four four-gallon tins of this material, no fewer than fifty species, of which 44 are new species of fossil chitons. As hitherto the number of authentic fossil chitons known from Australia was under twenty, the present additions more than treble the known fauna.

Still another species, which is represented by a unique specimen found in soil belonging to the United States National Museum and from the same exposures, is described. This unique specimen has been presented to the South Australian Museum.

The great increase in our knowledge of the Australian Fossil Chitons, due to the success of Dr. Sule's method, should stimulate interest in the Polyplacophora (Loricata), and seems to indicate that our ideas of the class may need considerable revision.

The beautiful figures here reproduced were prepared by Miss Varena Nottage, and, as an aid to the identification and understanding of the species, the missing parts of the valves have been reconstructed, the original portion being demarcated by a dark line.

PROTOCHITON Ashby, 1901.

PROTOCHITON GRANULOSUS Ashby and Torr, 1901.

The taxonomic importance of the above species cannot be too strongly stressed. Pilsbry (4) wrote: "It is commonly known that the earlier (Palaeozoic) Chitons are without insertion plates, and belong therefore to the family *Lepidopleuridae*." In 1900 (5) he proposed his sub-order *Eoplacophora* for the reception of all Palaeozoic genera, and adds: "None of the Palaeozoic genera are known to continue into the Mesozoic, but are replaced by types more related to modern Chitons."

While the genus *Lepidopleurus* (still extant) has no insertion plates, it is recognized by most students as being the progenitor of all living forms, and that the development of the insertion plate commenced with the end valves. Ashby (3) has shown that the genus *Protochiton* has no insertion plate in either of the end valves, but has begun to form one, still incomplete, in the median valves. It seems certain therefore that the genus *Protochiton* cannot have been derived through any member of the family *Lepidopleuridae*; it is undoubtedly the progenitor of the large family *Acanthochitonidae*. It would seem that the Acanthochitonids have been derived from primitive (Palaeozoic) stock along a separate and parallel line to that which produced the *Lepidopleuridae*. Further, the tail valve of "*Chiton gemmatus* de Koninck" from the Carboniferous beds of Dunfermline, Scotland, in the peculiar character of the outward extension of the tegmentum, absence of insertion plate, and general shape, is seemingly the prototype of the tail valve of *Protochiton granulatus* Ashby and Torr. The grains in the sculpture of *P. granulatus* are hollow, with a black dot on each grain, probably a sense organ, in which case the hollow grain may have been filled with "nerve fibre", a feature we do not remember to have seen in any living Chiton. We conclude that the strange extension to the tegmentum, common to both *Chiton gemmatus* de Koninck and *Protochiton granulatus* Ashby and Torr, is a primitive survival factor, giving increased surface for the girdle attachment which was later discarded in favour of an extension of the articulamentum to form the insertion plate and eaves. From the single tin (four gallons) of material from Clifton Bank (Lower Miocene) nine valves or fragments of valves of this species were obtained; one being a fairly perfect tail valve, the others median valves.

? *PROTOCHITON* sp.

From the same exposure also, comes a single median valve which is Acanthochitonoid in character, but with hollow grains which are widely different from those of the above species. As this is too imperfect to make a holotype, its description is deferred in the hope that future work will produce a better preserved example of what must be a very interesting species.

AFOSSOCHITON Ashby, 1925.

AFOSSOCHITON SULCI sp. nov.

Plate xx, fig. 21.

Head valve only, length 1.0 mm., width 1.25 mm. Straw coloured. Raised, anterior slope convex and steep. Entire surface, under X30 Zeiss binocular, evenly covered with circular, flat-topped polished, minute grains, which, although

crowded, appear not to touch. Five ray ribs, three central ones strongly raised, outer ones little more than mere folds.

Articulamentum. Insertion plate extending well forward beyond tegmentum for one-fifth of width of latter; colour white, three central ray ribs continued right across insertion plate, which is folded up, the fold standing out beyond the margin of the insertion plate; no trace of a slit.

Tegmentum inside without sculpture, turned over to an unusual degree; three dark-coloured apertures in three depressions corresponding with the three ray ribs of the tegmentum, and each almost corresponding with the edge of tegmentum above.

Holotype. McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4340, S.A.M. Beautifully preserved.

We have great pleasure in naming this important discovery after Dr. Sule, to whose labours we are indebted for its discovery. Because of its excellent state of preservation, this specimen amply justifies Ashby's primitive genus, *Afossochiton*, which has all the characters of *Acanthochiton* except that of slits, and can be regarded as a direct progenitor of *Acanthochiton*. The three dark-coloured apertures suggest large nerve channels connecting with the girdle at its junction with the tegmentum; exactly similar features do not occur in living Chitons.

AFOSSOCHITON CUDMOREI Ashby, 1925.

Plate xx, fig. 22.

One median valve from McDonald's, Miocene (Kalimnan).

TELOCHITON subg. nov.

Sculpture conforming to that of *Afossochiton*, but ray ribs of anterior and other valves continued right across insertion plate in narrow raised ribs, which (in some cases) do not seem to be a prolongation of the tegmentum, but are built up out of the articulamentum. Genotype, *Afossochiton (Telochiton) dendus* sp. nov.

AFOSSOCHITON (TELOCHITON) DENDUS sp. nov.

Plate xx, fig. 24.

Incomplete head valve only; length of piece 3 mm., width 3 mm. Tegmentum occupies about one-third of valve, insertion plate very wide; sculpture of crowded elliptical small grains with no definite arrangement, those grains surmounting the ray ribs sometimes larger, some several times as large, in one place apparently fused, larger near the posterior margin; five strongly raised ray ribs, the space

concave between the two posterior and the one next to them; an unusual feature is that each rib in the tegmentum is continued right across the broad insertion plate in a narrow sharply-raised rib, apparently built of the lower layer of the articulation; this appearance is not due to attrition of the tegmentum, for, in places, the anterior edge of the tegmentum has sculpture of small grains.

Articulation. White; tegmentum folded over at apex of valve, continuation of ray ribs across the insertion plate not by a prolongation of tegmentum but by a building-up of the articulation. No slits, but insertion plate edge considerably damaged.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria. Lower Miocene. P. 4342.

AFOSSOCHITON (TELOCHITON) ISCUS sp. nov.

Plate xix, fig. 20.

Tail valve only, length 2 mm., width 3 mm., much elevated and arched, mucro at posterior third, tegmentum behind mucro vertical, reduced to one-third only of area of shell; dorsal area very narrow, sides parallel, not wedge-shaped, with a narrow short groove on either side, the posterior portion of this area worn, though a perfect specimen may have a short second groove making this area narrowly and partially pinnatifid; area behind mucro, small, evenly covered with closely-packed small, rounded, ball-like grains, posterior margin with two very large grains and a third smaller one suggesting the beginning of a very coarse broken rib; a most unusual feature typical of this subgenus, and situated next to the girdle at the posterior portion of the insertion plate, are three ribs traversing the insertion plate, one in line with the dorsal area, and one on either side diverging. (Since writing this description, one rib has flaked off.) These do not appear to be narrow ridges of the tegmentum, but are rather narrow thickenings of the articulation. No slits. Area anterior to mucro decorated on either side with four horizontal rows of globular to subelliptical grains; the pattern is so regular that transverse rows of grains are formed.

Articulation. White; hollow under mucro unusually deep, either the sutural laminae were weak or the larger portion is missing.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4339, S.A.M.

AFOSSOCHITON (TELOCHITON) MAGNICOSTATUS sp. nov.

Plate xx, fig. 23.

One median valve only, length 5 mm., width 6.5 mm., angle of divergence 90°. Carinated, beaked, dorsal ridge longitudinally convex, side slope steep; dorsal area

flaked off, evidently longitudinally curved; pleural area diagonally concave, decorated with rather large elliptical grains arranged diagonally in longitudinal rows in some places; many of grains rectangular on the upper end, obtusely rounded at the lower; most striking feature is an exceptionally narrow and high diagonal rib starting from the prominent beak and reaching the girdle not far posterior of the middle of the valve; pleural area bends upwards at the diagonal rib, making pleural area concave; top of rib as wide as a single large elliptical grain; pleural area slope to top of diagonal rib gradual, but on the other side, that of the lateral area, the slope is vertical; consequently lateral area is depressed, and at a considerably lower level than the pleural area; sculpture of depressed lateral area similar to that of pleural, but grains there a little more spaced.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalinman). P. 4343, S.A.M.

The narrow, much raised diagonal rib and depressed lateral area easily distinguish this *Afossachiton*. What appears to be an extension of the sutural laminae is on one side crossed by an extension of the diagonal rib. This feature is the sole justification for placing the species under *Telochiton*. That a fragile fragment of the tegmentum does, at the diagonal rib, extend across the articulamentum, is quite certain. Any but very cautious handling of the valve will break this. There still remains a possibility that the whole of the articulamentum showing has been produced by the flaking off of the tegmentum, for in places pieces of grain appear to have been removed and then to have adhered to the articulamentum, or this appearance may be due to scars; additional examples are required for exact determination of this point.

ACANTHOCHITON Gray, 1821.

ACANTHOCHITON FORSYTHENSIS sp. nov.

Plate xx, fig. 26.

Two median valves. One, length 1.25 mm., width 2 mm. (holotype), and the other, length 3 mm., width 3.8 mm. (paratype).

Carinated, dorsal area broadly wedge-shaped and pinnatifid, beaked, surface smooth, lateral-pleural area decorated by longitudinal rows of triangular, spaced, flattish grains of four complete and one half-rows; grains regularly placed, forming rows either way; apex of triangular grains point downwards and forwards.

Articulamentum. White; insertion plates and sutural laminae broken off, tegmentum folded back at the beak, in centre of the valve articulamentum much thickened from one side to the other.

Holotype: Forsyth's Grange Burn, near Hamilton, Victoria, Pliocene (Kalinman). P. 4345.

Paratype: Same locality, median valve.

A further specimen from Clifton Bank, median valve, length 1.5 mm., width 2 mm.

This species differs from *Afossochiton cudmorei* Ashby in that the triangular grains are arranged regularly, while in *cudmorei* they are very irregular, dorsal areas not pinnatifid, and the carination less sharp.

ACANTHOCHITON FORSYTHENSIS RELATUS sub.sp. nov.

One median valve. Differs from *forsythensis* in lateral area being indicated by a shallow fold, grains arranged diagonally, but dorsal area and grains similar.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene.

ACANTHOCHITON DRUNES sp. nov.

Plate xx, fig. 29.

One median valve, length 1.5 mm., width 2 mm. Dorsal area worn, narrower than in *forsythensis*, not pinnatifid, but suggests longitudinal striation; ridge straight, not arched; pleural-lateral area decorated with straight longitudinal rows of grains arranged on the diagonal and almost, sometimes actually, touching; grains elliptical, slightly rounded at apex, flattish but not actually flat; five rows of grains, one next to girdle has three grains and one next to dorsal has worn grains.

Articulamentum. Sutural laminae present but worn, broad, shallow anteriorly, sinus between wide; insertion plates have no indication of slit, though absence may be due to wearing.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalinman). P. 4348, S.A.M.

ACANTHOCHITON CASUS sp. nov.

Plate xx, fig. 30.

One median valve only; length 1.5 mm., width 2 mm. Side slope steep; dorsal area, ridged, curved, and arched, less broad than in *Acanthochiton forsythensis* due to smaller angle of divergence, subpinnatifid, three grooves narrower than in *forsythensis*, lateral area not defined; pleural-lateral area slightly concave, outer edge becoming less steep; this area decorated with six and a partial seventh row of grains placed longitudinally; grains small, triangular, placed in rows at an acute angle, pointing forward; viewed transversely, rows are curved, not at right angles as in *forsythensis*; difference of pattern largely due to concavity of shell.

Articulamentum. Dirty-white; sutural laminae and insertion plates broken off.

Holotype: Clifton Bank, Grange Burn, Lower Miocene. P. 4349, S.A.M.

This species may be the progenitor of *Acanthochiton forsythensis*, for, in several respects, they resemble one another.

ACANTHOCHITON SABRATUS sp. nov.

Plate xx, fig. 25.

One median valve, length 1.75 mm., width 2.25 mm. Arched, not carinated, side slope convex and dorsal ridge beaked; dorsal area has sculpture worn away (if any was present), narrowly wedge-shaped as shown by the sculpture of pleural area at the anterior end; pleural area separated from lateral by narrow rib, but except for this rib, lateral area is at same level as pleural area; sculpture of both areas and of the rib itself identical; sculpture of small grains irregularly arranged and crowded, minute crowded round grains near the beak, across the pleural area grains are double the size, and for a short distance are in a semi-longitudinal arrangement, become a little longer in shape, then another change takes place, and a few grains along anterior margin are almost circular with flattish tops; briefly, grains are unusually small, with little pattern, and vary in shape.

Articulamentum. Dirty white; only a small fragment of sutural lamina present; we judge this to have been well developed, and sinus between fairly broad; all insertion plates missing; tegmentum folded over at beak.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4344, S.A.M.

LIRACHITON subg. nov.

Pleural area decorated with narrow, widely-spaced ribs, instead of granular ornamentation. In the genotype, *Acanthochiton (Lirachiton) inexpectus* sp. nov., the sculpture behind muero and in area corresponding with lateral area in median valve is formed of triangular flat grains; near the apex of each is an ocellus or sense organ. While we have provisionally placed the subgenus *Lirachiton* under *Acanthochiton*, it could be placed under *Afossochiton* with as much justification; the evidence of more material is needed to settle the point.

ACANTHOCHITON (LIRACHITON) INEXPECTUS sp. nov.

Plate xx, fig. 31.

One tail valve only; length 2 mm., width 2.5 mm. Shell arched, not carinated, side slope almost straight; in most of dorsal area tegmentum has broken off, but there is a little left at the anterior edge where it is smooth; muero a little posterior of central, slope behind muero steep and decorated with flat triangular grains,

most of which have been partially worn off, revealing that they are apparently hollow; at the sides, an area corresponding with lateral area in median valves where the triangular flat grains are well preserved and larger than the posterior ones; apertures situated near but not at the apex of each triangular grain, may be sense organs, but larger than those in hollow grains of *Protochiton granulatus*, corresponding with the ocelli common in several living genera; rest of portion anterior to muero and corresponding with pleural area, traversed longitudinally by three much raised, rounded ribs, the trough between these ribs broad, and the ribs themselves overhanging.

Articulamentum. White; hollow under muero wide and deep, nerve apertures exceptionally developed and numerous; slits not discernible, but two or three very shallow grooves may be connected with slits.

Holotype: McDonald's Muddy Creek, Pliocene (Kalinman). P. 4350, S.A.M.

The nearest allied living species is, we think, *Pseudotonicia cunata* Suter, from New Zealand.

ACANTHOCHITON PILSBRYOIDES sp. nov.

Plate xx, fig. 27.

One median valve only, length 2.25 mm., width 3 mm. Subcarinate, angle of divergence 110°. Dorsal area and small adjoining portion of pleural area eroded on one side, and whole of sculpture eroded on the other; major portion of sculpture on pleural-lateral area on the one side so well preserved and ornamentations so distinctive, that we describe it as new; sculpture of horizontal rows of grains, the larger portion in shape of rectangular ellipse, set in rows diagonally (similar to sculpture of the recent *Acanthochiton pilsbryi* Sykes), but near the dorsal area some grains are rhomboided and one or two fusiform.

Articulamentum. Insertion plate broad, no slits visible, but this may be due to erosion, which also accounts for bases only of the sutural laminae being left.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4346, S.A.M.

The specific name is suggested by the similarity of sculpture with that of the Australian recent species, *Acanthochiton pilsbryi* Sykes, but in the shape of the valves and absence of bridging in the sculpture, it is quite dissimilar.

ACANTHOCHITON TRIANGULOIDES sp. nov.

Plate xx, fig. 28.

One median valve, length 2 mm., width 2.25 mm. Rather flat, arched, and beaked, dorsal area narrow and wedge-shaped, anterior half granulosely sculp-

tured; much sculpture flaked off, but what remains shows rather long ovate-elliptical shallow grains, changing before the centre of area is reached to three shallow rows of small, indistinct grains; posterior half of this area smooth and polished; beak protrudes well beyond posterior margin of valve; pleural-lateral area decorated with eight or nine longitudinal rows of small, spaced, slightly-raised (obtuse-triangular) flat-topped grains; direction of rows not parallel, and in one place a short row is intercalated; arrangement of rows a little indistinct, some angles of lighting suggest more diagonal than longitudinal arrangement; grains evenly spaced throughout in the rows, and exceptionally even in size; no diagonal rib or fold, lateral area differing in that in the two outer rows at the posterior corner the grains, eight in all, are half as large again as the rest of the area.

Articulamentum. White; insertion plate and sutural laminae are missing.

Holotype: Forsyth's Grange Burn, Hamilton, Victoria, Pliocene (Kalimnan). P. 4347, S.A.M.

The sharply-cut, small, even in size, and subtriangular grains make this quite a distinctive species. If, when a perfect specimen should be found, the insertion plates are unsplit, the species will then have to be removed to *Afossochiton* Ashby.

The description was made while viewing the specimen under X30 Zeiss binocular.

CRYPTOPLAX Blainville, 1818.

CRYPTOPLAX PRITCHARDI Hall, 1904.

Plate xix, fig. 20.

Cryptoplax gatliffi Hall (6) is a synonym of the above species. Ashby (3) states: "The holotype of *C. gatliffi* differs in one respect only from the majority of specimens described as *C. pritchardi* Hall, in that it possesses a lobe-shaped plate on the inside, just under the apex." We now find that the "lobe-shaped plate" is common to all valves, although more marked in the three anterior valves. We find that Hall was incorrect in believing that any of the fossil examples he had seen showed the tegmentum, and we are confident that the only difference is that *pritchardi* is the remains of an ordinary median valve, and *gatliffi* was one of the three anterior valves of the same species. Ashby (3) also expressed the opinion that these worn "valves" may be of "non-Chitonoid origin". Now, thanks to Dr. Sule's washings, we have hundreds of these *Cryptoplax* valves, very few showing sculpture.

We now express the following opinions:

1. Holotypes of *pritchardi* and *gatliffi* and all previously recorded examples have no visible tegmentum, and all sculpture has been worn off.

2. Hundreds of these worn examples might reasonably be considered one species, because in living forms there is an equal discrepancy in the valves of a single specimen, the first two and often the first three valves are broad, and the rest narrow, subject to variations in the tail valve.

3. The present shape of these worn valves is often not at all the original form, but that as they have been ground out of all recognition by ceaseless rolling of the waves, a valve has often been shortened by nearly one-third.

4. Not one per cent. of the valves shows any sculpture. We offer the explanation that the shape is that of an elongate roller, which lends itself to rolling over and over with the slightest ripple, as well as in the more violent surf.

Pleisiotype. Out of the first examples of fossil *Cryptoplax* to show sufficient data for specific description, we select one as pleisiotype of the late Prof. Hall's *Cryptoplax pritchardi*, and we also place his *Cryptoplax gatliffi* as a synonym.

We also describe and name two distinct new species of *Cryptoplax* in the following pages.

Re-description from pleisiotype.

Median valve, length 6 mm., width 2 mm. Sharply raised, side slope convex, dorsal area very narrow, straight sides, raised, a little flattish top, beak slightly worn; sculpture forms one area at the beak consisting of spaced, circular or spherical small grains (truly Acanthochitonoid in character), from there the two upper ribs granulose for a third the length of valve; upper rib next the dorsal area continued parallel with the dorsal area almost to the anterior edge of the valve, and for the last two-thirds of its length is a strong irregular rib very coarsely toothed at its base on the upper side, the effect of the coarse teeth is to suggest a series of pits; on one side there are two outer ribs sculptured in the same manner one over half the length of valve, the other a little less than half, these two granulose for half their length, then change to the coarse-toothed sculpture; on the other side, while the two upper ribs correspond with the above description, there are also two outer short ribs (probably the outer one on the other side has been broken off); these two immediately beyond the granulose base near the beak become a series of confused, irregular, highly-polished grains.

Articulamentum. Creamy-white; sutural laminae worn, insertion plate worn; tegmentum bent over at posterior forming a pocket, the internal plate only showing as a hollow rise.

Paratype 1. Same locality, length 4.5 mm.; worn, whole of tegmentum present and in proportion to size, the granulose sculpture is a little more extensive.

Paratype 2. Length 4 mm., worn. Both 1 and 2 have well defined, raised dorsal area.

Pleisiotype and Paratypes; McDonald's Muddy Creek, Pliocene (Kalinman).

CRYPTOPLAX SICUS sp. nov.

Plate xix, fig. 17.

Large median valve (holotype), length 6 mm., long, narrow, steeply raised, beaked; dorsal area colour "tawny" (Ridgeway) narrow, straight-sided, strongly raised, rounded; sculpture, except at beak, composed of five dagger-like ribs on either side, ivory-like in appearance, commencing near the beak, narrow and slender, becoming swollen within a third of their length from the end, and then tapering to a sharp point, longest rib next to dorsal area, ending one-fifth short of the anterior edge of the valve; close to beak ribs show slight granulation at their sides, and so for a very short distance, but the beak itself is partly broken away, and there might have been a small amount of granulation had there been no breaking away.

Articulamentum. White; the damage to the valve has still left the little internal "plate" in perfect preservation.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalinman). P. 4336, S.A.M.

Paratype: One median valve, width 3 mm., worn, but showing most of the sculpture. Same locality as holotype.

Hypotype: Of head valve, only specimen; badly worn, but showing some sculpture, although not sufficient to make it holotype head valve. Same locality as holotype.

The name (from "*sica*", a dagger) is suggested by the dagger shape of the ribs.

CRYPTOPLAX NUMICUS sp. nov.

Plate xix, fig. 18.

One median valve only, length 3 mm., width 1.5 mm., in perfect state of preservation; wider than most species, arched, side slope less steep than usual; not beaked, but dorsal area slopes down to shell margin posteriorly; dorsal area has no raised, narrow dorsal ridge as in *C. pritchardi* and *C. sicus*, but presents a broader convex surface than either; it is possible that this area received a good deal of erosion, but the exceptionally well preserved sculpture on other portions of valve seem to contradict this idea; sculpture entirely granulose throughout, consisting of fine granulose longitudinal ribs, the outer one very short, little more than the granulose thickening of the posterior edge of the tegmentum; upper rib close to edge of dorsal area, indistinct in places, possibly due to wearing, grains small, spherical, and mostly narrowly spaced.

Articulamentum. Creamy-white; insertion plate in good state of preservation, sutural laminae well defined, but shallow, tegmentum folded over at posterior

end, making that end slipper-heel shaped, a feature characteristic of *Cryptoplax*.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4337, S.A.M.

MOLACHITON gen. nov.

Dorsal area (worn in genotype) broad, smooth except for faint growth grooves; pleural area unique, crossed longitudinally with broad irregular ribs, composed of large grains shaped on upper side like a large molar tooth, whole series of grains in rib fused together, centre of each grain with a funnel-like depression, and in centre of funnel a black dot or nerve aperture; ribs near dorsal area short, several run forward into dorsal area, but too worn to show "ocelli", if present; twelve ribs showing between dorsal area and girdle; lateral area sharply up-folded at the posterior margin; both raised portion, trough below, and a small part of the adjoining outer edge of pleural area decorated with imbricating, sub-triangular sub-convex grains.

Genotype (monotype): *Molachiton naxus* sp. nov.

The unusual sculpture of the pleural areas with the sensory organ in the centre of each molar-shaped fused grain, and the absence of insertion plate or sutural lamina, precludes determination of the true position of the genus in the natural taxis, so provisionally we place it in the family *Lepidopleuridae*.

MOLACHITON NAXUS sp. nov.

Plate xx, fig. 32.

One half median valve only, length 4 mm., width 4 mm. Strongly beaked, dorsal area a good deal worn, broad, smooth except for faint growth grooves; pleural area unique, crossed longitudinally by broad irregular ribs composed of large grains in the shape of a large molar tooth; whole series in rib fused together; a funnel-shaped depression in centre of each grain, and in its centre a black dot or nerve aperture (ocellus), ribs near dorsal area short, and several run forward into that area; these are too worn to show ocelli even if present; twelve ribs showing in pleural area; lateral area sharply up-folded at posterior margin; both raised portion, the trough (hollow below) and small part of adjoining outer edge of pleural area decorated with imbricating, subtriangular, sub-convex grains.

Articulation. Cream; insertion plate and sutural laminae missing.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4251, S.A.M.

BELCHITON gen. nov.

Sculpture of pleural area consists of slender longitudinal ridges surmounted with minute spherical glossy or porcelain grains; the interspaces twice the width

of the granular ridges and shallowly bridged below each grain; lateral area covered with closely-packed radial rows of grains similar to those of the pleural area, the rows in places intercalated with shorter rows; lateral area not raised as a whole, but near dorsal area and girdle are two shallow upward folds; sutural lamina in genotype appears perfect, weak and shallow, quite characteristic of palaeozoic forms; in common with *Protochiton granulatus* Ashby and Torr, each granule has a black dot or "sense aperture" at the summit. We place this genus in the family *Lepidopleuridae*.

Genotype (monotype): *Belchiton pulcherrimus* sp. nov.

The sculpture is so different from any other genus of *Lepidopleuridae* that we propose the above new genus.

BELCHITON PULCHERRIMUS sp. nov.

Plate xix, fig. 10.

Two fragments median valves, good condition; larger (holotype) 3 mm. wide, smaller 2 mm. wide. Fragments almost square (reconstructed in figure); pleural area crossed longitudinally by numerous extremely slender riblets, each carrying at the top, tiny spherical glossy or porcelain-like grains; near the dorsal area, riblets are crowded, several short ones intercalated, where this occurs almost touching; from there until girdle is reached, riblets are in proportion to their width, widely separated, each turning upward on reaching lateral area; an important feature of sculpture in the pleural area is the bridging, the transverse sculpture, very slender and shallow, crosses from grain to grain; lateral area closely covered with radial rows of grains of same character as those in pleural area, which do not seem to surmount a ridge, but lie on the surface; shorter rows intercalate in places; lateral area not raised as a whole, but near both dorsal area and girdle a shallow upward fold; grains in both areas with a black dot or aperture in their apices, no doubt associated with sensory organs, a primitive feature found in the genus *Protochiton* Ashby.

Articulation. White; sutural lamina very small both ways (quite primitive in character), and placed towards outer margin; tegmentum turned over full length of posterior margin.

Holotype: McDonald's, Hamilton, Victoria, Lower Pliocene (Kalinman). P. 4329, S.A.M.

The beauty of the sculpture suggests the name. A Zeiss X30 binocular and pocket lens X20 were used for examination.

LEPIDOPLEURUS Risso, 1826.

LEPIDOPLEURUS NIVARUS sp. nov.

Plate xix, fig. 5.

One median valve, holotype, length 2 mm., width 4.9 mm. Valve arched, not carinated, angle of divergence 105° , side slope slightly convex, dorsal area eroded, shell bowed forward at beak; pleural area well preserved, crossed longitudinally by narrow granlose ribs, a few bifid, many wavy; interspaces two to three times the width of ribs; lateral area sharply raised and closely decorated with five ray rows which almost touch; grains small, circular, and rounded.

Articulamentum. Probably originally white, now stained; thickened across middle, no insertion plate.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4324, S.A.M.

Paratypes: Two fragments median valves, same locality.

LEPIDOPLEURUS PAMPILIUS sp. nov.

Plate xix, fig. 2.

One median valve only, length 1.9 mm., width 3 mm., angle of divergence 90° . Side slope straight, arched, not carinated, dorsal area beaked, broadly wedge-shaped, striate with slender, closely packed, minutely granulose riblets; division between dorsal area and pleural area ill-defined because similar slender riblets to those of dorsal area are continued for at least one-third of the pleural area, and from there until lateral area is reached, grains and riblets, of which they are part, increase till two or three times their size; lateral area raised, narrow, ornamented with closely-packed granules, which commence quite minute at the dorsal area, increasing in size towards the girdle, but even these are not as large as the adjoining portion of pleural area.

Articulamentum. White; the lamina on one side perfect except for small notch, demonstrating that laminae of this genus are weak and produced very far apart, a feature this genus has in common with all known forms of palaeozoic chitons from the Primary Carboniferous Beds of Europe; no insertion plate.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4321, S.A.M.

LEPIDOPLEURUS BADIOIDES sp. nov.

Plate xix, fig. 4; xxi, 47.

Tail valve, length 1.75 mm., width 2.25 mm. Mucro at anterior third, immediately behind mucro shell is vertical, from there posterior area is at a steep

angle, flattening out a little near posterior margin; whole of this area posterior to muero and including both sides of muero clothed with closely-packed radiating minutely granulose riblets; small area anterior to muero evenly decorated with proportionately widely-spaced granular riblets, while coarser than those of posterior portion, still slender; this sculpture present not only at sides of the valve but continued over anterior half of dorsal area, which seems unsculptured at muero itself.

Articulamentum. No insertion plate, sutural laminae much reduced and far apart.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4323, S.A.M. Fig. 4.

Hypotype of median valve. One well preserved, length 1.5 mm., width 3.25 mm., from Forsyth's, Pliocene (Kalinan), subearinated, side slope convex; sculpture similar to that of area anterior to muero in holotype, but direction of slender riblets in lateral area radial.

Articulamentum. Cream; no insertion plate, sutural laminae missing, tegumentum folded over under beak. Fig. 47. P. 4358, S.A.M.

Paratype 1: Tail valve, broken, length 1.25 mm., width 2 mm., posterior and sides of muero clothed with closely-packed radiating minutely granulose riblets, a good deal obscured owing to wear. Same locality.

Paratype 2: Fragment of median valve—same locality as paratype 1.

The name *badioides* is suggested by the similarity to the recent *badius* Hedley and Hull.

? *LEPIDOPLEURUS UXELLUS* sp. nov.

Plate xix, fig. 13.

A portion of tail valve, length 1.25 mm., width 2.25 mm. Muero well defined, central, almost vertical immediately behind the muero; from there to posterior margin shell is very flat, decorated with closely-packed radiating subgranulose riblets; width and crowding of riblets almost identical with the similar riblets in *Lepidopleurus badioides* Ashby and Cotton, but in *uxellus*, granulation is only partial; posterior area ends abruptly at the muero, not carried forward along the sides as in *L. badioides*; area anterior to muero much raised and decorated by numerous, strong, longitudinal, pectinated ribs (not granulose), the interspaces deep and about half the width of ribs; this sculpture carried right across dorsal area, which is striate for its full length, the whole of the tegumentum is slate-grey.

Articulamentum. Greyish-blue; no evidence of insertion plate; a steep narrow ridge commencing V-shaped under muero and reaching outer anterior margin on either side; one side incomplete (due to breaking away), but on the other side,

ridge is perfect, and shows a deep groove commencing at girdle and ending near centre of valve; we do not recall a similar ridge in any other chiton.

Holotype: Forsyth's, Grange Burn, Pliocene (Kalinman). P. 4332, S.A.M.

Although we have placed this species under the genus *Lepidopleurus* failing further data, the flatness of the area behind the mucro, the colour of artienlamentum, and to some extent the sculpture of the area anterior to the mucro, are not characteristic of the genus *Lepidopleurus*.

LEPIDOPLEURUS MAGNOGRANIFER Ashby, 1925.

Plate xix, fig. 3.

Four portions of median valves from Clifton Bank. The holotype described by Ashby (3) was picked from among fossils collected by Dennant and Tate from the general locality "Muddy Creek", some of which were also described by Ashby and Torr (1).

We now designate the holotype locality as Clifton Bank, Grange Burn, Lower Miocene. Specimen figured Pleisiotype, P. 4322, S.A.M., has better preserved sculpture than that of the holotype.

LEPIDOPLEURUS RELATUS sp. nov.

Plate xix, fig. 12.

One incomplete median valve, length 2.25 mm., width 4.5 mm., angle of divergence 90°, valve arched, side slope convex, dorsal area with some inconspicuous slender network sculpture, much confused; pleural area near to dorsal area crossed by crowded longitudinal ribs; from there they become widely spaced, still parallel to each other, but becoming more and more bent upwards near the lateral area; ribs themselves very narrow, forming narrow, rather high ridges with minute granulation near their bases, those near the girdle become nearer together with granulation on top of ridges; lateral area much raised and closely covered with irregular pebble-like grains, pattern conspicuously in transverse rows, grains in each row about the same size, but a row with coarse grains may be next to one with small grains, posterior edge of this area consists entirely of large, pebble-like grains, three and a partial fourth radial grooves.

Artienlamentum. White; centre much thicker, thickening diverging on either side, but rapidly terminating in a point; no insertion plate, and sutural laminae broken off.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4331, S.A.M.

Paratypes: Two fragments of median valves.

Although resembling *Lepidopleurus magnogranifer* Ashby, *L. relatus* can be easily distinguished by the narrow longitudinal ribs and minute granulation.

LEPIDOPLEURUS SEPIUS sp. nov.

Plate xix, fig. 11.

One median valve, half one side missing, complete side, length 2 mm., width from dorsal ridge to girdle 4 mm., valve arched, side slope convex, angle of divergence 80° , dorsal area tegmentum absent, pleural area crossed longitudinally by rather strong parallel ribs; ribs definitely straight and parallel right to girdle, subgranulose; most important feature is that they are numerous and strongly bridged across, giving the sculpture a semi-honeycomb appearance; bridging does not reach top of ribs or the honeycombing would be more marked; lateral area raised and decorated with radial ribbing; furcate in some cases; ribs coarsely subgranulose, but most regular and almost smooth; total number of ribs and half-ribs, seven.

Articulamentum. Cream coloured; no insertion plate; remains of sutural lamina on one side only; lamina weak and shallow, tegmentum folded over along most of posterior margin.

Holotype: Forsyth's, Grange Burn, Hamilton, Victoria, Pliocene (Kalinman). P. 4330, S.A.M.

This species differs from both *magnogranifer* Ashby and *relatus* Ashby and Cotton in the marked bridging of the pleural area, and in the smooth, subgranulose ribs of the lateral area.

LEPIDOPLEURUS SINERVUS sp. nov.

Plate xix, fig. 7.

One almost complete head valve, length 1.9 mm., width 3.75 mm., sculpture of narrow riblets, closely-packed and smooth of surface, interspaces appearing under X20 magnifications as mere grooves, but at the bottom of groove in places pectinated; under X30 magnifications, the bottoms of grooves seem to be series of minute perforations; at one side, a few riblets surmounted with minute granules suggest that when newly-formed they may be minutely granular, a feature that is quickly lost; riblets consistently twenty-three to twenty-four to the millimetre.

Articulamentum. Cream; much thickened in centre, no insertion plate or sutural laminae.

Holotype: Forsyth's, Grange Burn, Hamilton, Victoria, Pliocene (Kalinman). P. 4326, S.A.M.

Paratype: Large fragment, possibly of a large head valve, same location.

LEPIDOPLEURUS SINGUS sp. nov.

Plate xix, fig. 8.

One tail valve only, length 2 mm., width 3.1 mm.; mucro not defined, shell strongly raised, sloping sharply from the anterior edge to middle of valve, and from there vertical to the girdle; whole shell decorated with longitudinal, mostly parallel, riblets, those in centre more slender and more closely packed than elsewhere on the valve; interspaces vary a good deal; where interspaces are wide, ridges are bridged across; where closer together this feature is reduced to a mere hole; thirteen riblets to the millimetre, but this count includes the central crowded narrower riblets, so we estimate that the riblets in this species are only half the number shown in the preceding species, *L. sinervus* Ashby and Cotton.

Articulamentum. Colour buff, sutural laminae seemingly complete, very small and laterally narrow; altogether they are unusually small for even this primitive genus.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4327, S.A.M.

LEPIDOPLEURUS BABIDUS sp. nov.

Plate xix, fig. 6.

One half median valve, length 1.9 mm., width 3 mm.; pleural area sculptured with longitudinal granulose widely-spaced ribs, but close together near dorsal area; interspaces twice, sometimes thrice, the width of rib; ribs parallel until near girdle, where they become irregular and weak; interspaces in pleural area shallowly bridged across; transverse shallow ridges correspond with grains which surmount the ribs; ribs turn upwards at the lateral area; lateral area much and irregularly raised, eight growth grooves, two outer ones at a much lower level than those above; sculpture of lateral area composed of numerous radiating subgranulose riblets touching one another; while these are much broken by the growth grooves, the general radial pattern is maintained.

Articulamentum. White; no insertion plate, sutural laminae absent.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4325, S.A.M.

Paratype: Two worn fragments median valves, same locality.

This species is easily separated from any other species herein described by the deep growth grooving in the lateral area, and from some others in the character of the bridging.

LEPIDOPLEURUS DIVERSIGRANOSUS sp. nov.

Plate xix, figs. 1 and 9.

One tail valve, length 2 mm., width 3 mm., mucro at anterior third, area behind mucro steep for two-thirds of area, and from there to outer margin almost flat, steep portion sculptured with minute grains forming under X20 a decussate pattern; outer portion of this area exhibits the start of about thirty granulose, radiating, shallow ribs, grains occupying about same area as four of the minute grains referred to above; area anterior to mucro narrow and longitudinally crossed by numerous, shallow, narrow, subpleated riblets, interspaces vary from same width as riblets to twice that width; dorsal area wedge-shaped, small, similarly minutely decussate as in area immediately posterior to mucro.

Articulamentum. Cream; saucer-shape, no insertion plate (Fig. 9).

Holotype: Clifton Bank, Lower Miocene. P. 4328, S.A.M.

Hypotype of median valve, from same locality, width 2.75 mm., rather flat, side slope straight; part of dorsal area flaked off, what remains minutely granulose; pleural area decorated with slender, rather irregular, minutely pectinated or subgranulose riblets; lateral area separated from pleural by a rather coarsely granulose rib, much of this area minutely granulose, granules double the size of those of dorsal area, and no regular pattern; grains near girdle much larger and very irregular. The hypotype valve only. Fig. 1. P. 4320, S.A.M.

CALLOCHITON Gray, 1847.

CALLOCHITON MACDONALDI sp. nov.

Plate xxi, fig. 46.

One median valve, length 1.5 mm., width 3.5 mm., shell is arched rather than carinated, side slope straight, tegmentum of dorsal area largely missing, but was evidently smooth and ill-defined; pleural area smooth, without sculpture except for four or five shallow growth grooves distinguished only by lateral lighting; lateral area raised and smooth, crossed by three broad and deep growth grooves; colour pinkish-cinnamon (Ridgeway).

Articulamentum. White; sutural laminae weak and shallow, sinus between 1 mm. wide, broad in proportion to size of valve; articulamentum not joined across sinus, but edge of tegmentum slightly overhangs; a strong raised rib runs from dorsal hollow almost to margin on either side. Shell arched rather than carinated, side slope straight, angle of divergence 100° .

Holotype: Muddy Creek, McDonald's, Hamilton, Victoria, Lower Pliocene

(Kalimnan). P. 4368, S.A.M. Unique example presented by the National Museum, Washington, U.S.A., to the Ashby collection in the South Australian Museum. The valve was unfortunately broken in the washing, and was mended by Dr. Sule before being sent to us. Although we have placed the species in *Callochiton*, the shape resembles that of *Loricella*, but the weak sutural laminae and complete absence of forward extension of the artienlamentum in the sutural sinns absolutely removes it from *Loricella*. The tegmentum surface in *Callochiton* seen under X30 magnification is minutely decussate, a feature absent from *macdonaldi*; there is no insertion plate, but we assume this has broken off. We provisionally place the species in *Callochiton*.

ISCHNOCHITON Gray, 1847.

In the material before us there are several fragments of median valve of two allied members of this genus; the sculpture of the pleural areas in these fragments may be broadly described as vermiform, wavy, or V-shaped. While these forms of sculpture exist in living species, it is probable that had we a complete set of valves of these fossil species, the combination of sculpture would more nearly conform to the regular recent *Ischnochiton* pattern than it appears to do in the fragmentary valves.

ISCHNOCHITON VINAZUS sp. nov.

Plate xx, fig. 36.

One half median valve, width 3 mm., pleural area decussate near dorsal area, but in outer half riblets become vermiform, wavy, and increase in size towards the girdle; two outer ribs stouter; lateral area raised, on anterior edge next to pleural area a row of eight very coarse grains, third grain from girdle part of one of the extra stout ribs before-mentioned, continued right across lateral area; three further coarse transverse bars or elongate coarse grains; interspaces or true surface of this area covered with small, inconspicuous grains.

Articulamentum. White; most of insertion plate and whole of sutural lamina broken away.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4335, S.A.M.

Paratypes: Two fragments of median valves; lateral area with isolated pustules rather than bars. Same locality.

ISCHNOCHITON TISURUS sp. nov.

Plate xix, fig. 15; xx, 35.

One half median valve 3 mm. wide. Pleural area with narrow crowded riblets without pattern near the dorsal area, become small crowded riblets with a partial

diagonal direction, but in outer half of area they form an irregular V-shaped pattern; lateral area raised at anterior edge, and here rather worn; rest of area crossed by six or more bars, of which three are composed of angular shallow grains; other bars badly worn.

Articulamentum. White; insertion plate and sutural laminae missing.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4334, S.A.M. Fig. 15.

Paratype 1: Fragment of median valve, same locality.

Paratype 2: Half median valve from Forsyth's, Pliocene (Kalimnan).

Hypotype—of tail valve, length 2 mm., width 3 mm. Forsyth's Pliocene (Kalimnan), muero central, but broken; slope behind muero somewhat steep at first, then becoming very flat, only a small part of sculpture present formed of concentric rows of less coarse pustules than those of lateral area of holotype; sculpture of anterior portion of this valve corresponds exactly with V-shaped pattern of pleural area of median valve. This solitary specimen is associated with *Ischnochiton tisorus*. Fig. 35, P. 4354, S.A.M.

ISCHNOCHITON COSSYRUS sp. nov.

Plate xx, fig. 37.

One tail valve only, length 3.75 mm., width 5 mm. Flattish, muero central, area behind muero nearly vertical for a short distance, then sloping at 45° to the girdle; very little sculpture left, but what remains shows that this area was radially ribbed with shallow ribs irregularly surmounted with rather shallow pustule-like grains and elongate grains; whole surface of shell was minutely granulose with decussate pattern; area anterior to muero was decorated with rather coarse, more or less disjointed vermiform or wavy riblets; dorsal area flaked away.

Articulamentum. Large V-shaped area with its base bounded by two sutural laminae, and apex under muero with bifurcating branchlets on either side pure white; rest of inside cream; insertion plate much worn away, but evidences of slitting exist; sutural laminae weak (probably reduced by attrition); sutural sinus wide.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4356, S.A.M.

ISCHNOCHITON NUMANTIUS sp. nov.

Plate xix, fig. 16.

One almost complete and well preserved tail valve, length 3 mm., width 3.75 mm.; muero slightly anterior of central, dorsal area broken away; area behind muero steep at first, then to outer edge concave; whole of this area decorated with

closely-packed subgranulose ribs, thirty-five in all; many intercalated and not full length; granulation most even throughout with exception of anterior rib, where it is coarser; a small area immediately behind the muero smooth except for minute granulation; area anterior to muero minutely deussate, a pattern formed by minute subgranulose strings crossing one another at right angles.

Articulamentum. The central V-shaped portion slightly raised; cream, with about five short wavy branches on either side; rest of valve white; insertion plate broken off, but slight evidences of slitting remain; only bases of sutural laminae remain.

Holotype: Forsyth's, Grange Burn, Hamilton, Victoria, Pliocene (Kalinman). P. 4335, S.A.M.

ISCHNOCHITON DURRUS sp. nov.

Plate xx, fig. 33.

One juvenile tail valve, length 1.25 mm., width 2.25 mm., in excellent state of preservation; unusually flat, muero at anterior third; area immediately behind muero at first almost vertical, and then continued at an angle of 47° until half-way across area, and from there to margin almost flat; muero and a patch equal to one-third width of whole valve and dorsal area, smooth, without any signs of sculpture; rest of posterior area consisting of a narrow region between the unsculptured patch and the posterior margin of shell, and two large patches on either side evenly and regularly sculptured with three concentric rows of spaced, rather large grains; on either side are several short rows arranged in the same way as the three outer ones; area anterior to muero narrow and small, what sculpture present is minutely granular, and under X30 magnification a few parallel transverse scratches are visible; the apparent unsculptured character of the anterior area (which corresponds with the pleural area in median valves) may take an additional pattern in the adult form, but the sculpture of the posterior area is likely to be maintained.

Articulamentum. Bluish-white; nine very clearly marked scratches radiating from beneath the muero to outer edge at girdle; these probably correspond with nine slits which, owing to damage of insertion plate, cannot be seen; "scratches" may be really nerve channels, the specimen presenting one of the best examples of this feature seen; insertion plate broken away; sutural laminae were certainly weak and far apart, only the bases remaining.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalinman). P. 4352, S.A.M.

ISCHNOCHITON NEGLECTUS sp. nov.

Plate xx, fig. 34.

Half median valve, width 3 mm., dorsal area missing; pleural area sculptured with eleven longitudinal ribs, well preserved, but several towards girdle badly worn; ribs high and narrow, and each rib has at the summit a complete row of minute, polished, spherical grains, quite even in size, a little smaller than width of rib, and all spaced fully the width of a single grain apart; lateral area raised and sculptured with seven spaced radial rows of large grains twenty times the size of minute grains referred to in pleural area; most of these grains spherical, but row adjoining pleural area larger and variable in shape; near the girdle grains smaller and less raised.

Articulamentum. White; base of insertion plate possibly showing, sutural laminae absent, tegmentum folded over at posterior margin.

Holotype: Forsyth's, Grange Burn, Hamilton, Victoria, Pliocene (Kalinman). P. 4353, S.A.M.

Paratypes: Several fragments of median valves, one possibly has insertion plate showing as in holotype, but the rest have no sign of it.

There are no complete valves, so the data available is not sufficient to determine accurately the generic position. We have decided to describe it under the genus *Ischnochiton*.

RADIELLA Pilsbry, 1892.

ISCHNOCHITON (RADIELLA) CLIFTONENSIS sp. nov.

Plate xix, fig. 14.

One median valve, length 4 mm., width 7.3 mm., angle of divergence 110° , valve well worn, subearinated, side slope slightly concave; sculpture of dorsal area and small portion of pleural entirely eroded; sculpture of remainder consists of a series of strong longitudinal ribs which furcate or sometimes fuse; ribs flattened out in places to double their normal width, and then a short distance away narrow rapidly to normal width; lateral area not in any way defined; whole surface of valve with same sculpture except where worn away; longitudinal ribs interconnected by narrow diagonal ribs of the same height; with lateral lighting this "bridging" gives a "honeycomb" effect, but with vertical lighting surface appears as if studded with deep pits somewhat cuneiform in character.

Articulamentum. Cream; much thickened from the hollow under beak out

towards girdle; insertion plate and sutural laminae worn off, so there is doubt as to generic character.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4333, S.A.M.

Sculpture suggests affinity with Pilsbry's subgenus of *Ischnochiton*, *Radsilla*, of which South Africa has two representatives, but hitherto neither recent nor fossil representatives have been discovered in Australia.

GENUS CALLISTOCHITON Dall, 1881.

Relatively much more time has been expended in the examination of numerous fragments (mostly median valves) of this genus, than on valves of other genera.

This is principally due to the following features:

1. The great variety of sculpture in a single individual.
2. The wide changes in sculpture from that of the juvenile to adult.
3. The depth of sculpture in this genus frequently makes a half-worn individual look entirely different from a perfect specimen.

CALLISTOCHITON GREEDI sp. nov.

Plate xxi, fig. 41.

Median valve, width 2.5 mm.; dorsal area missing; pleural area with only seven complete longitudinal ribs remaining; ribs strong, almost straight and parallel, ridges high and many interspaces double width of ribs; ribs bridged from bases; ribs do not turn upwards on reaching lateral area; lateral area composed of two strong nodulose, radiating ribs with a deep groove between, occupying the whole of this area; at bottom of groove ribs are bridged across forming a series of small pits; arrangement of nodules suggests a number of funnels or cones fitted one into the other; eleven nodules, some broken.

Articulamentum. White; sutural lamina weak.

Holotype: Forsyth's, Grange Burn, Hamilton, Victoria, Pliocene (Kalimnan). P. 4369, S.A.M.

Coarseness and regularity of ribs in pleural area distinguish the species. Named after Mr. Walter Greed, of Hamilton, Victoria, to whom we are indebted for packing the material sent to Dr. Sule for washing.

Paratypes: There are four other fragments of median valves belonging to this species, same locality.

CALLISTOCHITON RETICULATUS sp. nov.

Plate xxi, figs. 44, 45.

One complete median valve, length 1.25 mm., width 3 mm.; valve arched, side slope convex, a longitudinal ridge corresponds with cap and suggests subearination; dorsal area not defined, but decorated with slender network sculpture continued well into the pleural area; beak broken away, slender network sculpture occupying a third of anterior portion of valve, in longitudinal rows fairly parallel to one another; network sculpture replaced at the posterior margin by widely-spaced longitudinal slender ribs; these ribs turn up acutely at the girdle, making the ribs falcate rather than longitudinal; falcate ribs four, widest interspace four times width of rib; all interspaces between ribs narrowly and closely crossed by slender threads of sculpture; lateral area composed of two highly raised, nodulose, narrow radial ribs; five nodules and next to dorsal area three elongate grains, sulcus between the two ribs deep, and does not appear to have any bridging.

Articulamentum. Pale bluish-grey; sutural lamina and insertion plate missing; tegmentum folded right across from side to side.

Holotype: McDonald's, Muddy Creek, Pliocene (Kaiman). P. 4370, S.A.M. Fig. 44.

The nearest living species is *Callistochiton generos* Iredale and Hull, from which the species under review is easily separated; amongst other differences, *C. generos* has a granular dorsal area and sharply-sloping posterior portion of tail valve, whereas in *C. reticulatus* the former has network and the latter is flat. Fig. 45, P. 4383, S.A.M.

Hypotype: Tail valve taken as type of that valve. Fragment three-quarters of whole, width 2.5 mm., micro central, area behind micro flat, decorated with ten nodulose ray ribs; dorsal area anterior to micro, broad; all network sculpture like holotype, rest of anterior area with nine longitudinal ribs as in pleural area of holotype, except that, owing to flat posterior portion, these ribs are barely falcate. Locality same as holotype.

Paratype: One median valve, length 2 mm., width 5.5 mm., flatly arched, side slope unusually convex, angle of divergence 100° , dorsal area beaked, sculpture a good deal flaked and worn. Clifton Bank, Lower Miocene, one specimen.

In addition, there are two half-median valves, and two partly damaged tail valves from Forsyth's.

CALLISTOCHITON INEXPECTUS sp. nov.

Plate xxi, figs. 41, 42.

Median valve, juvenile, length 1.75 mm., width 4 mm., subearinated side slope very slightly convex, rather flat, angle of divergence 110° ; dorsal and pleural areas

indistinguishable; a form of decussate sculpture minute near the posterior of dorsal ridge and increasing in size, anteriorly and laterally; sculpture of this portion in less worn examples strictly of network form, in which the strands are coarser and apertures of mesh much smaller than in *C. reticulatus*; three short diagonal ribs show close to girdle (an adult would no doubt have this feature far more developed); lateral areas formed by two coarse radial ribs, of which the nodules numbering five to six better resemble the flange of a wheel, and continue down into the sulcus between the two ribs, causing the ribs to be coarsely bridged across.

Articulationum. Pale-grey; insertion plate and sutural laminae missing, tegmentum folded over for the full length of the posterior margin of this valve.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4372, S.A.M. Fig. 42.

Hypotype: Type of tail valve, length 1.5 mm., width 3 mm., muero slightly anterior to centre, raised, at first very steep, and from there to posterior margin slightly sloping only; posterior area at first smooth behind the muero, rest of this area decorated with eight nodulose ribs; nodules of ribs correspond with two broken concentric ribs; area anterior to muero small and without sculpture; surface and interspaces of both areas show signs of minute granulation. Same locality as holotype. Fig. 41.

In addition, there is one more tail valve and one more median valve of this species from the same locality.

The nearest recent species is *Callistochiton meridionalis* Ashby (3), from which *inexpectus* differs in the stouter nodules of the lateral areas, the flatter posterior portion of the tail valve, and the entire absence of surface granulation.

ANTHOCHITON Thiele, 1893.

Thiele, in "Das Gebiss der Schnecken, 1893", proposed three subgenera under the genus *Chiton*, namely *Clathropleura*, *Rhysoplax*, and *Anthochiton*, but only the last-named can date from 1893, because the genotype species of the other two were not published until 1909. Therefore those two subgenera date from 1909. We use *Anthochiton* Thiele, 1893, as a full genus.

ANTHOCHITON MACDONALDENSIS sp. nov.

Plate xxi, fig. 39.

Tail valve, length 2.5 mm., width 3.75 mm., muero at anterior third, tegmentum worn off muero, posterior slope from muero straight at an angle of 43°; polished, straw colour, surface minutely decussate, a few shallow growth grooves, but no sculpture in the area posterior to muero; area anterior to muero small, separated

from posterior area by a shallow fold, upper half smooth and polished like the posterior area, but lower or outer half possesses three fairly strong polished ribs; ribs short owing to narrowness of this area; ribs begin at the "fold" and terminate at anterior edge of valve; anterior edge minutely granulose by lateral lighting.

Articulamentum. Creamy-white; insertion plate worn away, but evidences of numerous slitting; sutural laminae absent.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4359, S.A.M.

ANTHOCHITON DUODENI sp. nov.

Plate xx, fig. 38.

One small fragment of median valve; very small, but portion of pleural area decorated with twelve narrow, strongly-raised ribs, each of which bends upwards at the lateral area, interspaces double width of ribs; lateral area smooth, but with several well-marked growth lines; this area strongly raised, slightly overhanging pleural area.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4357, S.A.M. Name suggested by the twelve ribs.

ANTHOCHITON OCTOCOSTATUS sp. nov.

Plate xxi, fig. 40.

Three-quarters of median valve; single side 3 mm. wide; carinated, side slope straight, angle of divergence 100° ; tegmentum flaked off dorsal area, surface of valve minutely decussate, only definite sculpture eight longitudinal widely-spaced ribs, interspaces three to four times width of ribs themselves.

Articulamentum. White.

Holotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). P. 4360, S.A.M. Name suggested by the eight ribs.

LORICELLA Pilsbry, 1893.

LORICELLA MAGNOPUSTULOSA sp. nov.

Plate xxi, figs. 50, 53.

Head valve, length 4 mm., width 7 mm., posterior edge imperfect, insertion plate missing; apex steep and worn, lower half of shell rather flat; eight and portion of ninth ray ribs surmounted with two to three large, widely-spaced pustules; surface of shell smooth, exhibits evidence of wearing.

Articulamentum. Buffish-white, shows signs of wearing, nerve perforations correspond with ray ribs in tegmentum.

Holotype: McDonald's, Muddy Creek, Lower Pliocene (Kalimnan). P. 4365, S.A.M., Fig. 53.

Hypotype: Half median valve, broken, taken as type of median valve; length 3 mm., width of half-valve 10 mm.; insertion plate and sutural laminae missing; dorsal area and pleural areas inseparable except for two broad growth grooves, and towards girdle several minor growth grooves, but at junction of pleural area and lateral area fifteen short ridges, interspaces appearing like fourteen deep pits; lateral area defined by a very much raised diagonal rib surmounted by three larger widely-spaced pustules; most likely there were two more of these pustules nearer the dorsal area, as shell here shows signs of wearing; colour pinkish-cinnamon (Ridgeway), inside white. Same locality and horizon as holotype. P. 4364, S.A.M., Fig. 50.

Paratypes: Two head valves, much worn, appear to belong to this species, as they show faint signs of large pustules; same locality and horizon.

LORICELLA PAUCIPUSTULOSA Ashby and Torr, 1901.

Plate xxi, figs. 52, 54.

One tail valve, length 2.25, width 6 mm., no sculpture showing, though it may be worn off; as median valves only possess two inconspicuous shallow diagonal ribs carrying small, spaced pustules, it is possible that the tail valve never possessed any ribs; whole of upper surface of valve convex; anterior and posterior margin much thickened, and anal portion broadly upturned.

Hypotype: McDonald's, Muddy Creek, Pliocene (Kalimnan). We present this specimen as the Hypotype tail valve of the species *Loricella paucipustulosa* Ashby and Torr (1).

LORICELLA CONCAVA sp. nov.

Plate xxi, fig. 51.

Tail valve, length 1.5 mm., width 3.25 mm., very flat, dorsal area much raised, straight-sided, pleural area and lateral areas consist of one depressed smooth surface; posterior edge much thickened and raised, so that the pleural-lateral areas are concave: tail upturned, posterior edge bending inwards at the upturned portion; only sculpture in pleural lateral area consists of four growth grooves at anterior portion and two at the anal; the grooves traverse the areas, and continue up the posterior ridge.

Articulamentum. Insertion plates broken away, but sufficient of sutural laminae remain to indicate that they are broad and well developed, sutural laminae joined across the sinus, articulamentum extending beyond anterior edge of teg-

mentum; articulation much thickened and notched in centre, posterior end hollowed out under upturned tail, evidently associated with some body organ such as a syphon; from there to anterior edge of valve on either side articulation much thickened.

Holotype: McDonald's, Muddy Creek, Pliocene (Kaimann). P. 4367, S.A.M.

This remarkable little valve is definitely a *Loricella*. The tegumentum is in excellent state of preservation, and sufficient of the articulation is preserved to definitely state that in the thickening of the articulation, both in the centre and at the outer edge, it presents features hitherto unknown. The name *concaua* is suggested by the concave tail valve.

LORICA H. & A. Adams, 1852.

We naturally expected that one of the three valves in this material of juvenile *Lorica* would represent *L. compressa* Ashby and Torr. In neither *L. oculca* nor in *L. varena* is there any sign of the scattered large pustules (grains) in the lateral area that were mentioned in Ashby and Torr's description of *Lorica affinis*. This Ashby (3) considered a mere variety of *L. compressa*. We have now, through the kindness of F. A. Cudmore, examined a series taken at Table Cape, Tasmania, and we are satisfied that they are conspecific, the type of *L. compressa* being a badly worn example, and that of *L. affinis* a better preserved specimen of the same species. While it is quite possible that *L. compressa* may not always show this sculpture in the very juvenile stage, in the best example of the adult we have seen the coarse grains make their appearance at a very early stage of growth.

We believe that the three juvenile *Lorica* valves here described represent two different species, chiefly marked by the great difference in the angle of divergence, and both differ from *L. compressa* in the entire absence of coarse pustules in the lateral areas.

LORICA COMPRESSA Ashby and Torr, 1901.

There is one incomplete median valve that certainly belongs to the above species, and a tail valve which has lost all sculpture on the upper side, but is better preserved on the underside. The tail valve of *L. compressa* Ashby (1), (3) has not been figured or described, and the present specimen is too poorly preserved to form a hypotype. From Clifton Bank, Grange Burn, Lower Miocene.

LORICA OCULEA sp. nov.

Plate xxi, fig. 48.

Median valve, well preserved, but a small fragment missing; width 2 mm., angle of divergence 110°. Valve carinated, side slope straight, dorsal area ill-

defined, smooth except for two short and slender longitudinal ribs on either side; pleural area crossed by four subgranulose narrow high ribs, the interspaces three times width of ribs, each rib where it joins the lateral area with funnel-shaped pit, at the bottom of which is a black dot or aperture; in some lights this pit shows a shining spot, and it is certain these apertures lead to sense organs, which we assume are ocelli; lateral area much raised and minutely granulose; four transverse or growth ridges composed of larger granules than rest of lateral area; ridges under X30 Zeiss appear due to growth grooves which vary much in width, and the apparent large size of the grains on the ridges is an illusion caused by these grains catching more light.

Articulamentum. Cream; no definite slit can be seen, sutural laminae shallow but laterally wide, the sinus between wide, but a feature typical of both *Lorica* and *Loricella* is the joining across the sutural sinus of the two sutural laminae, by a forward extension of the articulamentum; this a marked feature of the holotype.

Holotype: Clifton Bank Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4362, S.A.M.

Paratype: Median valve, small fragment missing, width 2 mm., same locality. The black dot occurring in each valve is situated at the third of the lateral area from the girdle and a little posterior from the centre of the valve. It is circled by a ring of normal grains on this area; there is a rather large funnel-shaped aperture through the tegmentum and the articulamentum with what, at the bottom in ordinary light, appears to be a black dot. When the electric globe was almost directly above, the light was brilliantly reflected in the corner at the bottom of the deep funnel; again in good daylight the light from the window was squarely reflected. Hitherto, no oculae have been seen in this genus other than those at the junction of the ribs on the pleural area with the lateral area, so this discovery is the first record of the existence of "eyes" on the surface of the lateral areas (in fossil *Lorica*), and the first discovery of the preservation of the cornea in fossil forms. As in the adult fossil examples, the apertures at the junction of the ribs with the lateral area are much larger than in any known recent chitons; the nature of the sense organs has always been doubtful. This discovery seems to confirm the belief that they are true ocelli, and, owing to the position of the cornea at the bottom of a deep funnel preventing lateral sighting, it seems that they could only serve to distinguish daylight from dark because their deep setting prevents any lateral sighting.

LORICA VARENA sp. nov.

Plate xxi, fig. 49.

One complete juvenile median valve, width from dorsal ridge to girdle 1.5 mm., but, owing to steepness of carination, valve is only 2 mm. right across; angle

of divergence 80° (compared with 110° in *oculea*); compared to *oculea*, ribs in pleural area more granular, interspaces wider; lateral area has one very deep and wide growth groove (*oculea* has several), granulate, less crowded and grains less raised and more irregular, the ocelli similar in position and size; otherwise generally like *oculea*, except is one-third smaller.

Holotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene. P. 4361, S.A.M.

Oochiton Ashby, 1934.

Oochiton halli Ashby, 1934.

Plate xxi, fig. 55.

From one ten-gallon tin of fossiliferous soil from Clifton Bank, Hamilton, Victoria, Lower Miocene, twelve median valves or fragments, four head valves, and one tail valve of the above species.

The original holotype of the head valve of this species was destroyed when Mr. Edwin Ashby's house was burnt in a bushfire on March 9, 1934. We now describe a Neotype:

Head valve, length 2 mm., width 3 mm., height 2 mm., angle of divergence acute; highly elevated, apex slightly recurved, anterior slope very steep and concave (due to recurved apex); sculpture of strings of egg-like pustules similar to those in the other valves; arrangement generally speaking longitudinal, the strings commencing at the posterior margin and continuing to the insertion plate with considerable irregularity, several strings bifurcate, and in some places there are short intermediate rows; the strings or rows of pustules apparently have no relationship with the slits in insertion plate.

Articulamentum. Creamy white; highly polished, smooth, without any grooves; tegmentum unfolded at the apex, this unfolded portion thickly studded with egg-like pustules; insertion plate well produced, perfect except for a few minute chips; slits high, broad and short, spacing irregular; upper side of insertion plate numerously grooved, plate broad and proportionately thick, but upper edge bevelled off so that the actual edge is sharp, the grooves not continuing to the inner edge.

Neotype: Clifton Bank, Grange Burn, Hamilton, Victoria, Lower Miocene.

The sculpture of this *Oochiton* is quite unique, the angle of divergence unusually small, resulting in the carination of the median valves being very steep; the shape of the tail valve has no parallel in any living forms. The nearest to it is to be found in the upturned extremity of the same valve in the genus *Lorica*, and in both there would be body modifications to correspond.

We think that the two genera *Loricella* and *Lorica* seem to have little affinity with any other living forms, and may, together with *Oochiton*, have come down from Palaeozoic times along separate parallel channels to that of the *Lepidopleuridae*, as is certainly the case in the Acanthochitonoid group.

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EXPLANATION OF PLATES.

Plate xix.

- Fig. 1. *Lepidopleurus diversigranulosus* sp. nov., Hypotype.
 Fig. 2. *Lepidopleurus pamphilius* sp. nov., Holotype.
 Fig. 3. *Lepidopleurus magnogranifer* Ashby, Holotype.
 Fig. 4. *Lepidopleurus badioides* sp. nov., Holotype.
 Fig. 5. *Lepidopleurus nivarus* sp. nov., Holotype.
 Fig. 6. *Lepidopleurus babidus* sp. nov., Holotype.
 Fig. 7. *Lepidopleurus sinereus* sp. nov., Holotype.
 Fig. 8. *Lepidopleurus singus* sp. nov., Holotype.
 Fig. 9. *Lepidopleurus diversigranus* sp. nov., Holotype.
 Fig. 10. *Belchiton pulcherrimus* sp. nov., Holotype.
 Fig. 11. *Lepidopleurus sephus* sp. nov., Holotype.
 Fig. 12. *Lepidopleurus relalus* sp. nov., Holotype.
 Fig. 13. *Lepidopleurus uxellus* sp. nov., Holotype.
 Fig. 14. *Ischnochiton (Radsietta) cliftonensis* sp. nov., Holotype.
 Fig. 15. *Ischnochiton tisurus* sp. nov., Holotype.
 Fig. 16. *Ischnochiton numantius* sp. nov., Holotype.
 Fig. 17. *Cryptoplax sicus* sp. nov., Holotype.
 Fig. 18. *Cryptoplax numicus* sp. nov., Holotype.
 Fig. 19. *Cryptoplax pritchardi* Hall, Hypotype.
 Fig. 20. *Afossochiton (Telochiton) iscus* sp. nov., Holotype.

Plate xx.

- Fig. 21. *Afossochiton sulci* sp. nov., Holotype.
 Fig. 22. *Afossochiton eudmorei* Ashby, Holotype.
 Fig. 23. *Afossochiton (Telochiton) magnicoslatus* sp. nov., Holotype.
 Fig. 24. *Afossochiton (Telochiton) dendus* sp. nov., Holotype.
 Fig. 25. *Acanthochiton sabratius* sp. nov., Holotype.
 Fig. 26. *Acanthochiton forsythensis* sp. nov., Holotype.
 Fig. 27. *Acanthochiton pilsbryoides* sp. nov., Holotype.
 Fig. 28. *Acanthochiton trianguloides* sp. nov., Holotype.
 Fig. 29. *Acanthochiton drusus* sp. nov., Holotype.
 Fig. 30. *Acanthochiton casus* sp. nov., Holotype.
 Fig. 31. *Acanthochiton (Lirachiton) inexpectus* sp. nov., Holotype.
 Fig. 32. *Molachiton naxus* sp. nov., Holotype.

- Fig. 33. *Isechnochiton durius* sp. nov., Holotype.
Fig. 34. *Isechnochiton neglectus* sp. nov., Holotype.
Fig. 35. *Isechnochiton lisurus* sp. nov., Hypotype.
Fig. 36. *Isechnochiton vinazus* sp. nov., Holotype.
Fig. 37. *Isechnochiton cossyrus* sp. nov., Holotype.
Fig. 38. *Anthochiton duodeni* sp. nov., Holotype.

Plate xxi.

- Fig. 39. *Anthochiton macdonaldensis* sp. nov., Holotype.
Fig. 40. *Anthochiton octocostus* sp. nov., Holotype.
Fig. 41. *Callistochiton inexpectus* sp. nov., Hypotype.
Fig. 42. *Callistochiton inexpectus* sp. nov., Holotype.
Fig. 43. *Callistochiton greedi* sp. nov., Holotype.
Fig. 44. *Callistochiton reticulatus* sp. nov., Holotype.
Fig. 45. *Callistochiton reticulatus* sp. nov., Hypotype.
Fig. 46. *Callochiton macdonaldi* sp. nov., Holotype.
Fig. 47. *Lepidopleurus badioides* sp. nov., Hypotype.
Fig. 48. *Lorica oculatea* sp. nov., Holotype.
Fig. 49. *Lorica varena* sp. nov., Holotype.
Fig. 50. *Loricella magnopustulosa* sp. nov., Hypotype.
Fig. 51. *Loricella concava* sp. nov., Holotype.
Fig. 52. *Loricella paucipustulosa* Ashby and Torr, Hypotype.
Fig. 53. *Loricella magnopustulosa* sp. nov., Holotype.
Fig. 54. *Loricella paucipustulosa* Ashby and Torr, Paratype.
Fig. 55. *Oochiton halli* Ashby, Pleisiotype.